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Integration of water management and land consolidation in rural areas to adapt to climate change: Experiences from Poland and the Netherlands

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ABSTRACT

Rural areas face major challenges in adapting to the impacts of climate change, in particular to floods and droughts. This calls for both adaptation of rural functions and climate-proof and water-resilient design of the rural area, often implying improvement of water retention and flood protection. Implementation of such climate change-related goals in spatial planning often involves adaptations in water management, perhaps even leading to land consolidation. Water management and land consolidation thus form important tools for spatial adaptation. Land consolidation is also a tool to support the integration of other claims that need room, such as agriculture, nature, landscape and tourism functions. This paper investigates the history of and approaches to land consolidation and water management in Poland and the Netherlands, and illustrates the integration of land consolidation and water management to realize a multifunctional climate resilient rural area by two examples in each country. We qualitatively compared the extent to which the planned activities in water retention and flood protection were realized and planned results were achieved for other functions. We found that the two adaptation measures, water retention and flood protection, were more effective in the Netherlands, stemming from ample attention for the impact of climate change and the incorporation of climate change adaptation goals in water policy. Furthermore, the water retention and flood protection measures in the Netherlands better serve multiple functions: agriculture, nature, recreation, landscape and infrastructure. Reasons for this are the multidisciplinary and participatory approach, attention to public awareness and communication and promotion of the process. On the other hand, the Dutch have much to learn from Poland's vast, undisturbed natural areas, which contribute to a climate resilient landscape. Both Poland and the Netherlands could therefore benefit from bringing together ideas and experiences regarding climate proofing the rural area.

1. Introduction

Water-related hazards like floods and droughts account for the majority of natural disasters worldwide (IFRC (International Federation of Red Cross and Red Crescent Societies), 2016), and it is foreseen that climate change will increase both impact and frequency of these water crises (e.g., IPCC, 2007, 2014; EEA (European Environmental Agency), 2017). Therefore, failing to adapt to climate change is among the greatest risks that the world is facing, according to the World Economic Forum (2017). These insights have resulted in greater priority for adaptation to climate change on international as well as national agendas, and in the formulation of international agreements and numerous international and national programmes to stimulate climate adaptation. For instance, the European Commission adopted in 2013 an EU strategy on adaptation to climate change with the aim of making Europe more climate resilient. The EU adaptation strategy focuses on promoting the development of adaptation strategies by member states, and helps them build their adaptation capacities and take action to promote adaptation in key vulnerable sectors, such as agriculture, fisheries and transport, and to provide adaptation information via the Climate-ADAPT platform. Furthermore, the European Commission agreed to spend at least 20% of its 2014–2020 budget to respond to the challenges and realize investments related to climate change.

This public and policy interest and the associated funding

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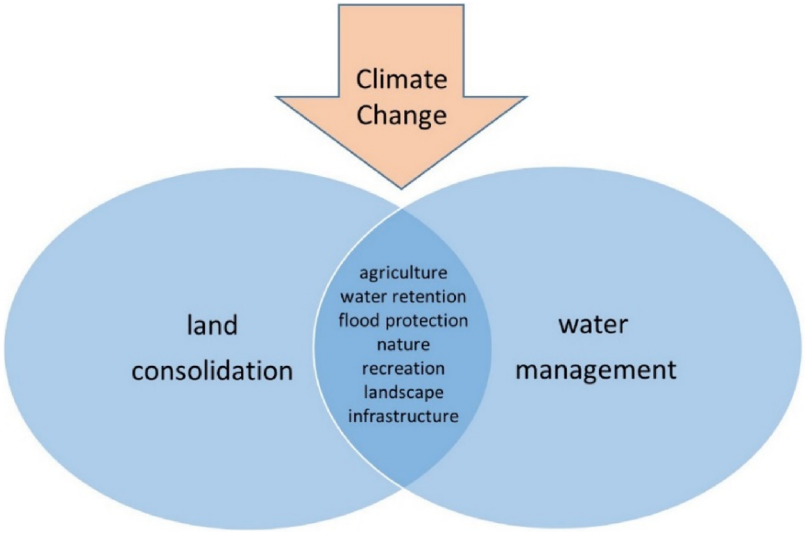

Fig. 1. Water retention and flood protection as measures to adapt to climate change for the realization of a multifunctional climate resilient landscape by integration of land consolidation and water management (Source: own elaboration).

opportunities for climate adaptation have stimulated regional and local governments as well as the private sector to start or to join initiatives on climate adaptation. The City Leaders Forum programme (AIWW (Amsterdam International Water Week), 2017) is an example of such an initiative. Here, cities, industries and utilities share experiences and collaborate in adapting urban areas to climate change. Several Dutch and Polish cities joined this programme. Both countries actively stimulate adaptation action on the local scale, and several cities in both the Netherlands and Poland have taken the initiative to develop local adaptation strategies and implement adaptation measures, and to strengthen Dutch-Polish collaboration.

In the Netherlands the Delta Programme stimulated major cities like Rotterdam and Amsterdam and regional capitals like Leeuwarden and Zwolle to adapt, and in Poland, for instance, the project "Development of Urban Adaptation Plans for Cities with More Than 100,000 Inhabitants in Poland" has been joined by 44 Polish cities, including Warsaw, Gdynia, Poznan and Wroclaw.

The rural area, however, also faces major challenges in adapting to climate change. Foreseen changes in temperatures, amounts and seasonal patterns of rainfall, and salt intrusion along the coast will have huge impacts on rural functions like agriculture and forestry and on nature (EEA (European Environmental Agency), 2017). These call for adaptation of agricultural and forestry practices as well as for a climate-proof and water-resilient design of the rural area. However, beyond the major challenge to adapt, rural areas also have considerable potential to play a role in climate adaptation, e.g., by providing space to store water during extreme rainfalls for release in dry periods (e.g., Ellen et al., 2011; Ritzema et al., 2016). These kinds of spatial adaptations may complement or even enhance spatial functions like nature conservation and restoration, recreation and tourism, or improve spatial quality. On the other hand, they may compete with other claims that need room, such as agricultural production. Furthermore, demographic and economic developments in rural areas, such as depopulation and the disappearance of facilities, pose additional challenges and opportunities to spatial adaptation. In this complex context, it is of utmost importance to balance all ambitions and tasks and involve important stakeholders in the search for climate-proof and water-resilient measures and designs for the rural area.

Spatial planning is a process whereby combinations of land uses can be fashioned to facilitate climate change adaptation (Hurlimann and March, 2012). Implementation of climate change-related goals in spatial planning often involves adaptations in water management, and may even result in land consolidation to realize climate-proof and water-resilient rural areas. Water management and land consolidation thus form important tools for spatial adaptation (Olesen and Bindi, 2002; Huq et al., 2015; Zeleňáková et al., 2015). Additionally, land consolidation forms a tool to support the multifunctional and sustainable development of rural areas (Janus and Markuszewska, 2017; Haldrup, 2015; Kupidura et al., 2014; Lisec et al., 2014; Pašakarnis and Maliene, 2010; Sklenicka, 2006; van Dijk, 2003).

Because of their mutual interest in climate adaptation and governmental support for collaboration and exchange of experiences between the Netherlands and Poland, we compare land consolidation and water management approaches in Poland and the Netherlands. Furthermore, we illustrate how land consolidation and water management can be integrated to realize a multifunctional climate resilient rural area. We present two examples in each country seeking insight into the effectiveness of measures and to distil lessons learned on adapting rural areas to climate change.

2. Materials and methods

2.1. Overview of main directions and changes in land consolidation and water management approaches in Poland and the Netherlands

We started with a review of scientific and grey literature related to rural water management and land consolidation practices in Poland and in the Netherlands, and presented an overview of the main directions and changes in land consolidation and water management in Poland and the Netherlands.

2.2. Ex-post assessment of the realization of multifunctional rural areas

Water retention and flood protection are the two most common measures for addressing the rising challenges of water management, namely, increasingly frequent and widespread flooding and drought. We looked at the effectiveness of integrating land consolidation and water management processes for realizing multiple functions in Poland and in the Netherlands. Two case studies in each country were examined, whereby 'effectiveness' was used to characterize a project or process's achievement of its intended effect (Clark, 2000; Helms, 2006; Kowal, 2013).We qualitatively compared the extent to which the planned activities in water retention and flood protection were realized and planned results were achieved for the multiple functions: agriculture, nature, recreation, landscape and infrastructure (ISO, 2005) (Fig. 1).

We selected four areas that faced increasingly complex challenges, and where rural development projects were carried out: Wąwolnica-Zarzeka and Siedliska in Poland and Munnikenland and Bussloo in the Netherlands.

The selection of the Polish study areas resulted from the involvement of Dutch experts in the projects. Both Polish cases were pilots realized within the Phare programme (Phare, 1998) and were considered innovative at that time in Poland (the pre-accession period). The substantive scope of the projects concerned the key aspects of multifunctional rural development, including agriculture, infrastructure, water retention and flood protection, landscape and natural environment.

Both Dutch cases were areas that faced a range of challenges, including impacts of climate change, and opted for innovative and multifunctional solutions in which local water management was completely integrated with land consolidation.

For all four cases we looked at (i) project design and technical documentation; (ii) cadastral maps, topographical, hydrological and land-use maps; and (iii) results of field visits and interviews with key stakeholders like water boards, landowners and local entrepreneurs.

3. Land consolidation and water management in Poland and the Netherlands

Europe has a long tradition of land consolidation and water management. Classic land consolidation focuses on addressing three types of constraints: (i) land splitting or fragmentation, in which many farmers each work an overly small farming area; (ii) multi-ownership, in which many owners share property rights in one holding; and (iii) land scattering, in which one farmer owns multiple plots dispersed over a wide area (Korthals Altes and Im, 2011). Both in Poland and in the Netherlands the scale of these constraints is spatially diverse as a consequence of historical, legal, social, economic and demographic processes (Leń and Król, 2016; Markuszewska, 2016). For instance, in Poland land fragmentation was highest in the south and south-eastern parts of the country, with additional problems related to unfavourable shape of parcels in eastern and central Poland (Leń, 2018). The largest farms were in the northern and western parts of Poland (Jędrejek et al., 2014). In the Netherlands, historically, land fragmentation was the highest on the sandy soils in the southern and eastern parts of the country, while farms in the fertile riverine area and along the coast were bigger and less fragmented (Van den Brink and Molema, 2008).

Typically, road construction or reconstruction, soil improvement and water management works accompany land consolidation programmes, to accommodate intensified land use, mechanisation and modern farming techniques. Water management measures may include improved drainage, irrigation and protection of low-lying areas against flooding (Van de Ven, 2004). Although land consolidation was in some European countries regulated by law as early as the eighteenth century (Pašakarnis and Maliene, 2010), both Poland and the Netherlands regulated land consolidation from the 1920 s (Fig. 2).

3.1. Poland's land consolidation history

Land consolidation (*Scalanie gruntów*) in Poland began in the fourteenth century mainly with programmes to adjoin lands belonging to the church. Nonetheless, subsequent farm divisions led to systematic growth in farm numbers and deteriorating farm productivity and profitability. In the early 1920 s, Poland introduced several policies to improve farm productivity: the Agricultural Reform Act of 1920, the Act on Melioration of 1921 and the Land Consolidation Act of 1923. Works pursuant to the acts affected some 5.4 million ha and 860,000 farms (Krupowicz, 2016). After World War II two acts guided rural development: the Agricultural Reform Decree of 1944 and the Decree on Exchange of Lands of 1949. These sought to join state and co-operative lands, but neglected farmers' needs. From 1968 to 1981, the main objective of land consolidation was to concentrate lands in the hands of the state and cooperatives. Some 335,000 ha per year were affected by land consolidation and exchange works (data from the Ministry of Agriculture and Rural Development). In 1982, the Act on Land Consolidation and Exchange was introduced. This modernized land consolidation, introducing as a main focus the rational distribution of parcels on farms with respect to the water system, roads and terrain.

In the years leading up to Poland's EU accession, 1982 to 2004, 28,866 ha per year underwent land consolidation and exchange (data from the Ministry of Agriculture and Rural Development). After 2004 this average fell to 13,909 ha per year (based on data from the Ministry of Agriculture and Rural Development) (Fig. 3). Over this period, economic impacts of land consolidation were: (i) growth of farm profits by 12% to 44%, (ii) an internal rate of return (IRR) between 4.9% and 15.0% annually and (iii) an investment recoupment period of 6 to 7 years (Woch, 2012). These outcomes were mainly attributed to the spatial improvements achieved. For the period of 2007–2013 the average coefficient of reduction of the total number of plots equals some 39.3%, whereas the coefficient of the increase in the size of an average plot equals 1.8 (Stańczuk-Gałwiaczek, 2017).

After Poland's EU accession in 2004, introduction of the idea of multifunctional and sustainable development led to a widening scope of land consolidation projects, encompassing environmental and landscape protection as well as rural development (Sobolewska–Mikulska, 2009). Poland is one of the biggest beneficiaries of EU-supported projects oriented to the development of rural area, where land consolidation works have a special position (Janus and Markuszewska, 2017). At present, there is a high demand for land consolidation in Poland, i.e., more than 7 million ha (about 69% of total agricultural land area) (Jędrejek et al., 2014). The greatest needs can be found in the south-eastern, central and southern parts of Poland (Woch, 2007). Here the size of farms varies between 7 and 15 ha (while in northern Poland the size exceeds 20 ha) and numbers of parcels exceeds 6 (Jędrejek et al., 2014). The current pace of implementation of land consolidation works is estimated at some 14,000 ha per year (estimated for the years 2005–2015).

3.2. Poland's water management history

Water management in Poland can be divided into three periods, echoing Polish history: the interwar period (1918–1939), the post-war period until the end of socialism (1945–1989) and the lead-up to and aftermath of Poland's EU accession (1989 to present). Throughout much of the interwar period, works were undertaken to improve soil water retention (Iwanicki, 2007), in line with the Water Melioration Act of 1921 (Act on promoting public reclamation companies), which also led to the creation of a state irrigation and drainage systems fund. More than 2.5 million ha of wasteland (swampy areas that flooded multiple times a year) were drained for agricultural purposes (Pijanowski, 2006, 2011). Water issues in Poland were governed by the Water Act of 1922.

In the post-war period until the end of socialism, central planning formed the core of Poland's economic system (Kaliński, 1995). Water management was aligned with government regulations connected with multi-annual economic plans. The Water Act of 1922 was replaced by other acts of the same name (1962, 1974). Activities to facilitate the use of rivers for navigation and power generation were continued, as well as for freshwater supply. With respect to rural areas, economic plans centred on intensification of agricultural production and creation of the largest possible expanses of new arable lands. This was achieved by construction of irrigation and drainage systems and regulation of small rivers. These developments largely overlooked nature values, which often led to reclamation of wetlands (Majewski, 2011). High consumption of water for agricultural purposes, alongside increasingly intensive production and use of artificial fertilizers had repercussions for the natural environment, particularly the quality of surface water and groundwater (Mioduszewski, 2004).

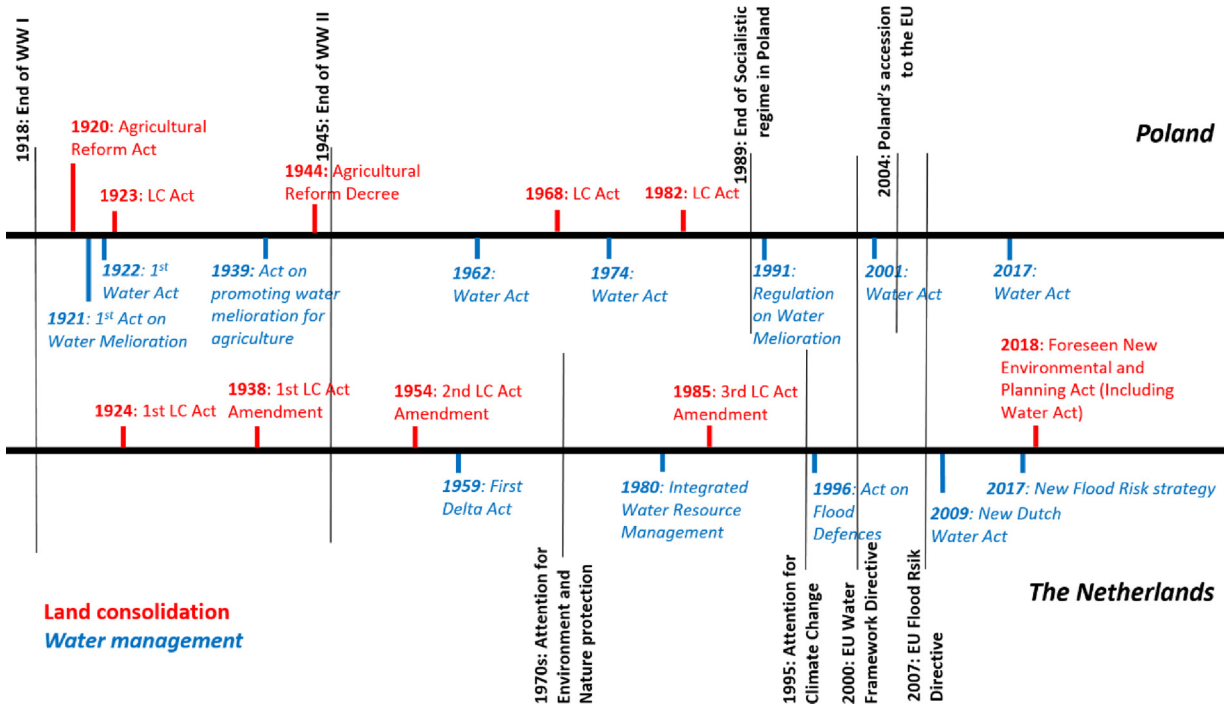
1918: End of WW I
1920: Agricultural Reform Act
1923: LC Act
1922: 1st Water Act
1921: 1st Act on Water Melioration
1939: Act on promoting water melioration for agriculture
1944: Agricultural Reform Decree
1945: End of WW II
1962: Water Act
1968: LC Act
1974: Water Act
1982: LC Act
1989: End of Socialistic regime in Poland
1991: Regulation on Water Melioration
2001: Water Act
2004: Poland's accession to the EU
2017: Water Act
Poland
1924: 1st LC Act
1938: 1st LC Act Amendment
1954: 2nd LC Act Amendment
1959: First Delta Act
1970s: Attention for Environment and Nature protection
1980: Integrated Water Resource Management
1985: 3rd LC Act Amendment
1995: Attention for Climate Change
1996: Act on Flood Defences
2000: EU Water Framework Directives
2007: EU Flood Rsik Directive
2009: New Dutch Water Act
2017: New Flood Risk strategy
2018: Foreseen New Environmental and Planning Act (Including Water Act)
The Netherlands
Land consolidation
Water management

Fig. 2. Changes in land consolidation (in red) and water management (in blue italics) policies in Poland and the Netherlands over time; *Key: LC – Land consolidation, EU – European Union, WW I – World War I, WW II – World War II* (Source: own elaboration) (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

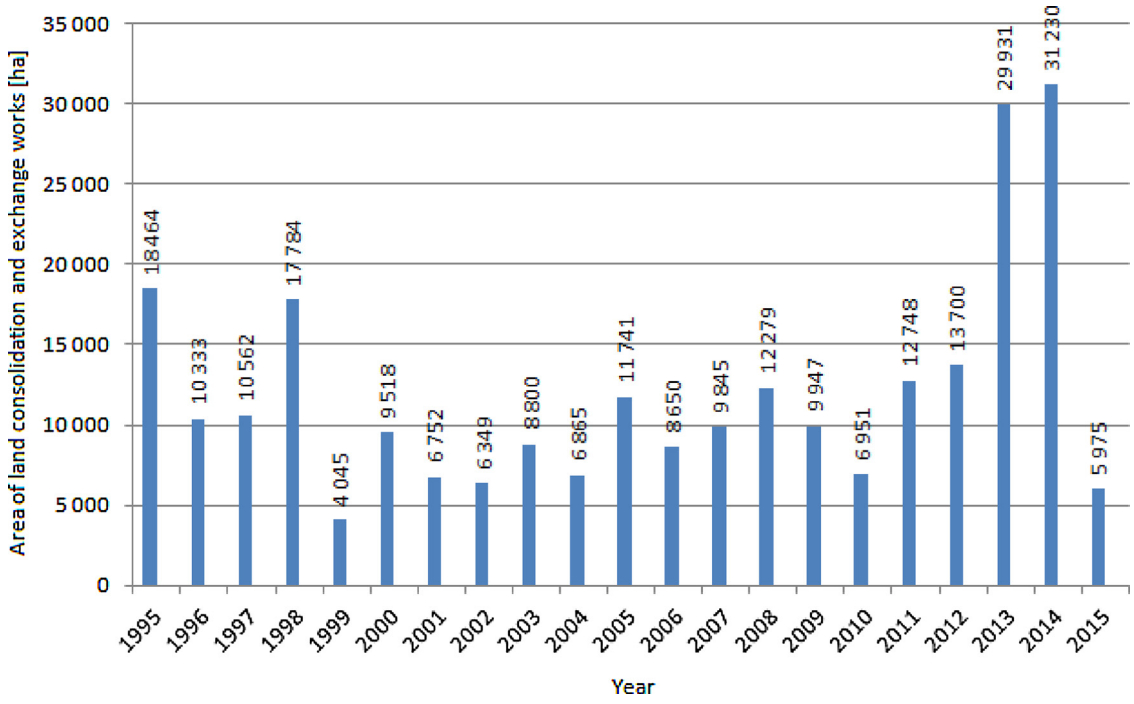

Fig. 3. The pace of implementation of land consolidation works in Poland from 1995 to 2015 (Source: data from the Ministry of Agriculture and Rural Development).

In 1989, when Poland began its transition to a free-market economic system, new guidelines for water management were needed. These were found in a new approach called integrated water resources management (IWRM). A new binding Water Act was adopted in 2001, which was replaced in 2017. To some extent, its structure replicates the previous versions of the corresponding legal acts. However, Poland's EU accession in 2004 did lead to translation of the EU Water Framework Directive 2000/60/EC into Polish legislation. In line with that directive, water management in rural areas is given greater attention (Mioduszewski, 2004). Attention is also paid to protecting the quality and quantity of water resources in the rural landscape.

Poland's EU accession boosted implementation of various water management activities and measures, such as construction of water reservoirs and small water retention networks, flood protection measures, (re-)construction of irrigation and drainage systems, natural reconstruction of water streams and sewage treatment. These projects and

programmes have helped the idea of sustainable and multifunctional rural development to take root in Poland.

Currently the country faces three main water management issues: (i) high temporal and spatial variability of rainfall and surface flows, (ii) frequent extreme hydrological events such as droughts and floods and (iii) inadequate water quality (Kundzewicz et al., 2010). Polish agriculture has suffered huge damages from periods of excessive water interspersed with water shortages (Mioduszewski, 2011). These have led to lowered water tables, disappearing water bodies and periodic drying-up of streams and surface flows (Borecki et al., 2004). The capacity of retention reservoirs in Poland is also very limited (about 3.6 km^3, or approximately 6% of the average annual outflow), compared to 10% to 12% in neighbouring countries (Małecki, Pokładek, 2010).

3.3. The Netherlands' land consolidation history

Dutch agriculture experienced a boom at the end of the nineteenth century, driven by specialization and technical innovations, such as artificial fertilizers, factory production of dairy products and better agricultural machinery, and by the rise of agricultural education and research (Van den Brink and Molema, 2008). This led to rapid growth in production and productivity, and increased land reclamation for agriculture. Land use was often fragmented and most agricultural parcels were insufficiently drained. From 1883–1910, the number of farm holdings with less than 5 ha increased by 64%. In 1910, 22% of the farm holdings in the higher sandy zones in the east and south of the country had a farm size less than 5 ha, compared to only 7% in the sea clay zones in the west and north. No exact figures are available on fragmentation of land holdings, but illustrative is the situation in the land consolidation of Ballumer Mieden on Ameland, which was carried out on a voluntary basis in 1915. This area of approximately 200 ha was divided into more than 4000 parcels, belonging to 119 owners. On average each owner had 1.7 ha, spread over about 33 plots (Van den Brink and Molema, 2008). During the early decades of the twentieth century, the Netherlands took its first steps in land consolidation. Initially, there was little government involvement, as property ownership was deemed a private concern. Nevertheless, the Land Consolidation Act came into force in 1924 (Van den Brink and Molema, 2008). Implementation of the act was slow because of complicated administrative requirements and limited governmental subsidies (Van den Noort, 1987). In 1930, over 80% of the farms in the sandy parts of the Netherlands were still smaller than 10 ha (Van den Berg, 2004). The act was amended in 1938. While promotion of agricultural development remained the aim, the application procedure was simplified and subsidies increased (Manten, 1975; Van den Noort, 1987).

After World War II, new elements were introduced in the Land Consolidation Act, such as relocation of farm buildings, construction of utility works, tenure regulations and, where necessary, enforced relocation of land users to new polders created in the IJsselmeer area. Also, special attention was given to landscaping. Among the aims was to improve agricultural conditions and production so as to delay the outflow of labour from the agricultural sector and stem the depopulation of the rural areas (Van Leeuwen, 1978). Though urban planning became more important in the post-war years, it was explicitly excluded from the Land Consolidation Act until 1954 (Molema, 2012). The act was then amended once more, expanding the purview of land consolidation to include the complete reconstruction of rural areas, including electrification, drinking water supply, social and cultural services, outdoor recreation and industrialization (Manten, 1975). In land consolidation, agrarian interests continued to dominate; in urban planning, public housing played the dominant role. In the large-scale infrastructure projects, transport and water control came first. This resulted in the need for a more multifunctional approach to integrate these diverse interests in a given area, underpinned by an increasing awareness of the limits of development with respect to the environment, energy, natural resources and employment.

At the end of the 1960 s, the countries of the EU set out to reform their agricultural policies. They decided to take at least 5 million ha of agricultural land out of production (7% of the EU's total agricultural area) (Prillevitz, 1970). For the Netherlands, this resulted in conversion of some 130,000 ha to non-agricultural uses in the 1970–1980 period. Among the new non-agricultural uses were nature reserves, landscape reserves, water bodies for recreation, urbanization and forest. In the 1970 s, publication of the Club of Rome report "The Limits to Growth" and public pressure brought increased emphasis on non-agricultural land uses and ecological values. To balance economic interests with ecology, nature and sustainability, the Land Consolidation Act was again amended in 1985. Nature was now cast as an independent entity to be designed and recreated if necessary in the Dutch landscape. Next to a productive agricultural landscape, re-naturalized landscapes for recreational purposes became increasingly important (Doevendans et al., 2007).

Over the period from 1924 to 2004, land consolidation and land development plans were implemented involving nearly 1.4 million ha in approximately 480 projects (Van den Brink and Molema, 2008). From 1955 to 1985, land consolidation was done at a rate of about 40,000 ha per year (Fig. 4). The economic return of these investments was high, with an average rate of return of 9% to the national economy for projects executed between 1960 and 1987 (Van den Noort, 1987). The return to farmers was even higher, as the government subsidized about two-thirds of land consolidation costs. Although the rate at which land consolidation projects are carried out has significantly decreased

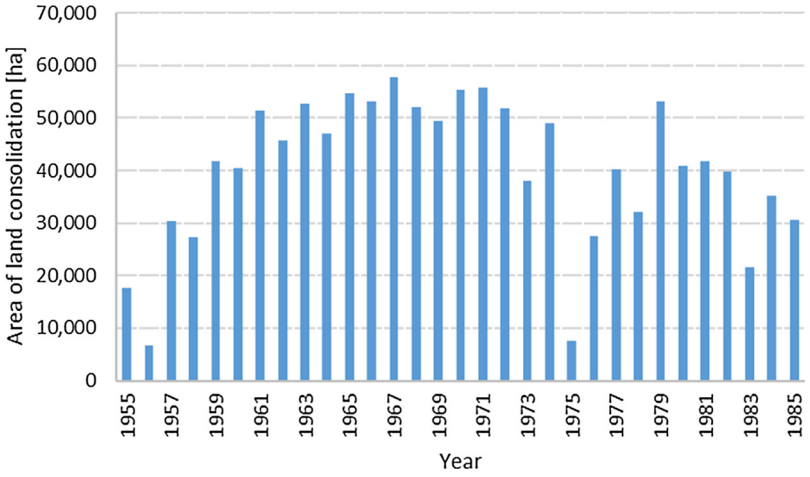

Fig. 4. The pace of implementation of land consolidation works in the Netherlands, 1955–1985 (Source: Van den Berg, 2004).

Fig. 5. Pilot locations in proposed agricultural mega-regions in Poland (Source: own elaboration).

since, the average size of farm holdings continues to grow, mainly because farmers retire and sell their land. As a consequence, the average farm holding for agricultural and pasture land (excluding horticulture, perennial cropland and granivore holdings) increased from 26.4 ha in 2000 to 31.0 ha in 2011 (LEI Wageningen UR and Centraal Bureau voor de Statistiek, 2012).

3.4. The Netherlands' water management history

The Netherlands has a long tradition of water management and flood protection. From the Middle Ages onwards, a collective system of agreements on dike building and management began to emerge (Van de Ven, 2004). Furthermore, from the Middle Ages onwards, many swamps were drained, which resulted in soil subsidence due to oxidation of the drained peat. This necessitated more extensive flood protection and drainage efforts (Mostert, 2006). To supervise these works, regional water boards were established (Van de Ven, 2004). In the late nineteenth century, land-use intensification and new farming techniques led to greater interest in water management (Van den Brink and Molema, 2008).

A flood disaster in 1916 prompted construction of a 32 km dam that closed off the former Zuiderzee inlet from the North Sea. Extensive parts of the newly formed lake were reclaimed during the 1930–1960 period. A subsequent flood disaster, in 1953, in the south-western Netherlands, provided impetus for the First Delta Act (1959) and the start of the "Delta Works", a large-scale infrastructure project to protect the country from flooding.

After the 1970 s, when recreation, nature conservation and landscape became more important, water management approaches evolved into more adaptive and participatory forms (Van der Brugge et al., 2005). In 1980, the concept of integrated water resource management (IWRM) was launched (Mostert, 2006), and became national policy in 1989. Furthermore, efforts began to comply with new international policies, such as the EU Water Framework Directive and the EU Nitrates Directive. Through the Agricultural Water Management Delta Plan (*Agrarisch Waterbeheer),* the government elicited increasing involvement of citizens and business people in implementing region-specific water management plans (http://agrarischwaterbeheer.nl/).

Regarding flood protection, the growing interest in nature and other values led to major redesign of some of the planned but not yet constructed Delta Works and to postponements and adjustments in dike reinforcement schemes. Two close calls with potentially disastrous river floods, in 1993 and 1995, due to extreme rainfall in winter, followed by a dry summer in 1995, led to adoption of the Act on Flood Defences in 1996. The near floods also launched climate change on the research agenda (Ritzema and van Loon-Steensma, 2017), and initiated a wholesale reconsideration of the Dutch flood protection strategy. Research has indicated that climate change will stretch the existing dense network of engineered watercourses and pumping stations that keep the low-lying Dutch land dry. Furthermore, the hydraulic works required to maintain suitable conditions for agriculture will become increasingly costly under climate change (Querner et al., 2012), calling for new solutions.

In 2006, the "Room for the River" programme was launched to give more space to rivers, in order to cope with high river discharges. In 2008, the Dutch government appointed an independent high-level committee, the Delta Commission, to recommend ways to improve protection of the Dutch coasts and low-lying regions against the expected impacts of climate change and sea level rise (Deltacommissie, 2008). In 2007 the EU Floods Directive concerning assessment and management of flood risk came into force. It prescribes development of flood risk management plans focusing on prevention (e.g., through land-use planning), protection and preparedness, alongside active involvement of all interested stakeholders in the process. In 2009, a new Dutch Water Act created a framework for a more modern Dutch water management in the coming decades. Currently the Water Act is incorporated into the new Environmental and Planning Act (*Omgevingwet*), set to enter into force in 2018. This is aligned with the inclusion of the so-called Delta Plan on Spatial Adaptation in the Delta Programme 2018 (Deltacommissioner, 2017).

4. Land and water management in rural development projects

4.1. Two examples from Poland

In Poland we selected two rural development projects in which Dutch experts were involved: Siedliska (Lower Silesian Province, south-west Poland) and Wąwolnica-Zarzeka (Lublin Province, south-east Poland) (Fig. 5). The aim of the pilot was to learn more about how land consolidation can be integrated within the overall context of rural development. Dutch experts from ILIS company, the Dutch Government Service for Land and Water (DLG, Dienst Landelijk Gebied) and FinnMap participated in the projects.

4.1.1. Siedliska Village development programme

Siedliska Village is located on the Brochotka 1 & 2 Rivers (51°15′ N, 16°02′ E). The area (720 ha) was characterized by a monotone landscape with little forest cover (approx. 5.10 ha) and problematic wind erosion. Large-scale farming was dominant in the area (average farm size is 5.27 ha, with an average of 4.5 parcels each). Before the project began, high water levels in Brochotka 1 River caused recurrent elevated groundwater levels, resulting in the presence of wetlands. Under the land consolidation and rural development programme a wide scope of activities was planned (Table 1).

With regard to the Brochotka 1 River, regulation was the most important water management task (Fig. 6). Measures to improve nature values were also proposed and approved, but not carried out. The river banks, however, were strengthened using stones in areas close to buildings and openwork concrete slabs in other places. Regarding Brochotka 2, riverbed conservation works were planned but not constructed under the project. However, to better regulate soil-water conditions and reduce flooding, a siphon was constructed under the river bed to drain off excess waters. Farmers initiated construction of this installation and covered its cost. The area requiring regulation of soil water relations in the initial plan was remained in its natural conditions as periodically wet areas. The planned reconstruction of

Table 1
Functions and planned activities under the Siedliska Village Development Programme. Data from the Lower Silesia Office of Geodesy and Rural Areas.

Functions	Planned Activities
water retention	- construction of installations for disposal of excess water
flood protection	- conservation of the riverbed of Brochotka 1 & 2 Rivers
	- river regulation
agriculture	- farm infrastructure improvements through tenancies and purchase of state lands (184 ha)
	- land consolidation improvements to farms (reduced number of parcels and increased average parcel size)
	- reconstruction of open drainage ditches and conservation of drainage system
nature	- improvement of riverine nature
landscape	- forestation along the agricultural access roads
	- planting clumps of trees on dry green areas to complement ecological corridors along the drainage ditches and rail line
	- development of ecological parcels (20 ha)
infrastructure	- development of new and reconstruction of existing agricultural access roads of a total length of 15.6 km
	- development of technical infrastructure, such as water supply networks, sewage disposal networks and station for cleaning agricultural machinery
	- provision of space for sports facilities, development of a village square, construction of fire station and community centre

open drainage ditches and conservation of the existing drainage network were not performed.

The water management interventions, including afforestation, met environmental and landscape conservation criteria. This allowed for recoupment of costs related to re-naturalization of the terrain. Landscape values were improved and, at the same time, impacts of wind erosion were reduced. Regarding agricultural production conditions, improved water management led to more financially stable farms. Following from this achievement and the associated improvements in living conditions, increased interest in village renovation was observed. For example, projects to improve the layout of built-up areas were evident as well as diversification of the landscape (e.g., planting of new trees, digging of fish ponds). Although the project objectives were not all met (Table 1) the project's positive effects will likely continue, stimulating further changes for the better in the village. Finally, the increased satisfaction of village residents regarding the improvements had spread to surrounding hamlets, spurring additional activities.

4.1.2. *Wąwolnica-Zarzeka rural development project*

The villages of Wąwolnica and Zarzeka are located near the Kazimierski Landscape Park (51°18′ N, 22°09′ E). Water erosion is strong here in the basin of the Bystra River. The landscape is varied and characterized by water-carved gorges. Arable lands cover more than 70% of the area (1200 ha) with predominantly high-quality loess soils. Before land consolidation, low-income, fragmented agricultural holdings with disadvantageous shapes and sizes ranging from 1 ha to 5 ha were dominant (average holding size 3.54 ha). Furthermore, the area had an overly dense network of agricultural roads which worsened soil degradation.

The project incorporated key elements of rural development associated with agriculture, infrastructure, water management, the landscape, natural protection against erosion and recreation (Table 2). Water management works were designed with consideration of the need to protect the natural environment and landscape. Landscape development works aimed to increase protection against water erosion.

The main intervention was a 12 ha water reservoir (Fig. 7). Besides the water retention function, the reservoir was to be highly important for recreation purposes. Horse trails, bike paths and hiking trails were planned along the reservoir, creating an area that would offer touristic value and contribute to development of agro-tourism in the area. Difficulties, however, were encountered in implementing the design. In 2012, the reservoir surface area was reduced to 6 ha on the planning documents (Studium, 2012). To date, however, the plans have not yet been realized for multiple reasons.

Firstly, the planned reservoir location requires changing the course of the Bystra River. This represents an unrealistic venture in Poland, for

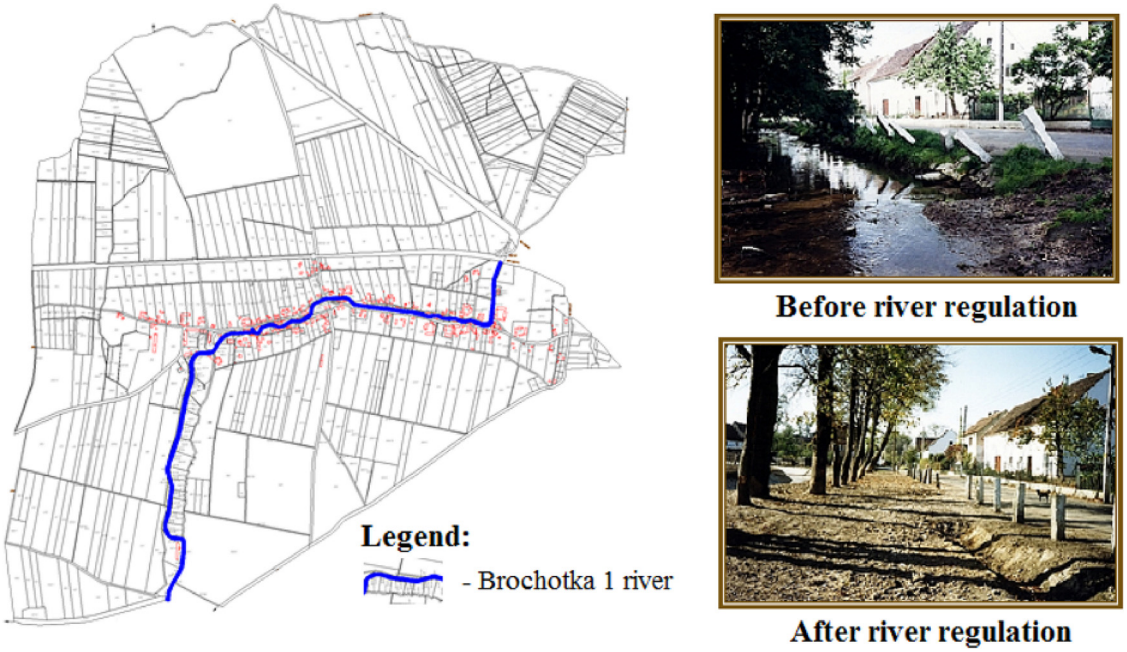

Fig. 6. Regulation of the Brochotka 1 River within the rural development project in Siedliska (Source: Lower Silesia Office of Geodesy and Rural Areas).

Table 2
Functions and planned activities under the Wąwolnica-Zarzeka Village Development Programme.

Functions	Planned Activities
water retention	- anti-erosion measures: facilities for draining surplus surface waters - construction of 12 ha water reservoir
flood protection	- changing the course of Bystra River
agriculture	- improvement of spatial structure of agricultural holdings
recreation and tourism	- construction of hiking trails, bike paths and horse trails
landscape (anti-erosion measures related to water management)	- planting trees and shrubs along the degraded loess slopes of Bystra River - planting trees along roads - allocation of grasslands on the slopes - afforestation on steep slopes
infrastructure	- development of agricultural road network adapted to the terrain - provision of space for recreation purposes and agro-tourism

financial and official reasons. For example, it would require a positive environmental assessment by the regional environmental protection directorate competent authority, which upholds a very restrictive policy.

Secondly, problems arose in obtaining land to implement the plan. The Wąwolnica Commune was the sole owner only of the land in the conservation zone directly adjacent to the reservoir and that under the designed reservoir (i.e., under the proposed water surface). Private individuals owned the surrounding lands, including the areas where a public beach was to be located with seasonal restaurants and car parks. Without the prospect of obtaining financial benefits from leasing the surrounding lands, the investment in development and maintenance of the area would be difficult to recoup. In 2017, a court ruling reinstated ownership of the lands concerned to the former owners (land co-ownership of Zarzeka village), which limited the potential for realizing the planned reservoir. The rural community is reluctant to make a long-term investment without the chance to get immediate returns from the land. Therefore, the main problem in this case was not obtaining funding for the reservoir (as plenty of funding options were available), but the acquisition of ownership of the lands surrounding the proposed reservoir. This halted the project.

4.2. Two example projects in the Netherlands

In the Netherlands, we selected projects in Munnikenland and Bussloo to demonstrate the Dutch approach to integrating land consolidation and water management (Fig. 8). Munnikenland is a "Room for the River" project and combines flood risk management with ambitions towards cultural heritage conservation, nature development and stimulation of recreation and tourism. Bussloo is a man-made water body that was converted into a recreational area and currently faces drought-related issues.

4.2.1. Munnikenland "Room for the River" project

Munnikenland (51°48′ N, 5°01′ E) is located in Bommelerwaard, a low-lying rural area in the central Netherlands bounded by the rivers Waal and Maas (Fig. 9). Bommelerwaard has been flooded numerous times, and its landscape is marked by floodplains, levees, ancient riverbeds and low-lying wet areas. The villages and buildings are located on higher ground, with the low-lying areas open and used for grazing. Munnikenland (700 ha) is situated just south of the Waal River, at the spot where the dammed off "Maas Canal" merges with the Waal River. In the distant past, in around 1200, the area consisted of a branch of islands, separated by creeks. Monks started to reclaim this wet, low-lying, frequently flooded, fertile riverine area for agricultural use by building dikes and developing a system of drainage ditches. Later, Loevestein Castle was built at this strategic location on the Waal River, which is a major transportation route even today. In the fifteenth century, drainage of the Bommelerwaard was improved using windmills, which in 1885 were replaced by two pumping stations. In the 1930 s, several canals were deepened and improved as part of a work provision programme (Regionaal Archief Rivierenland, 2015).

In the 1960 s, Munnikenland became part of a land consolidation project aimed to improve drainage infrastructure, increase the size of agricultural parcels and farms and relocate several farms from higher to lower grounds. Before implementation of the land consolidation and related water management improvements, this low-lying area was frequently inundated during winter. Until recently, Munnikenland was

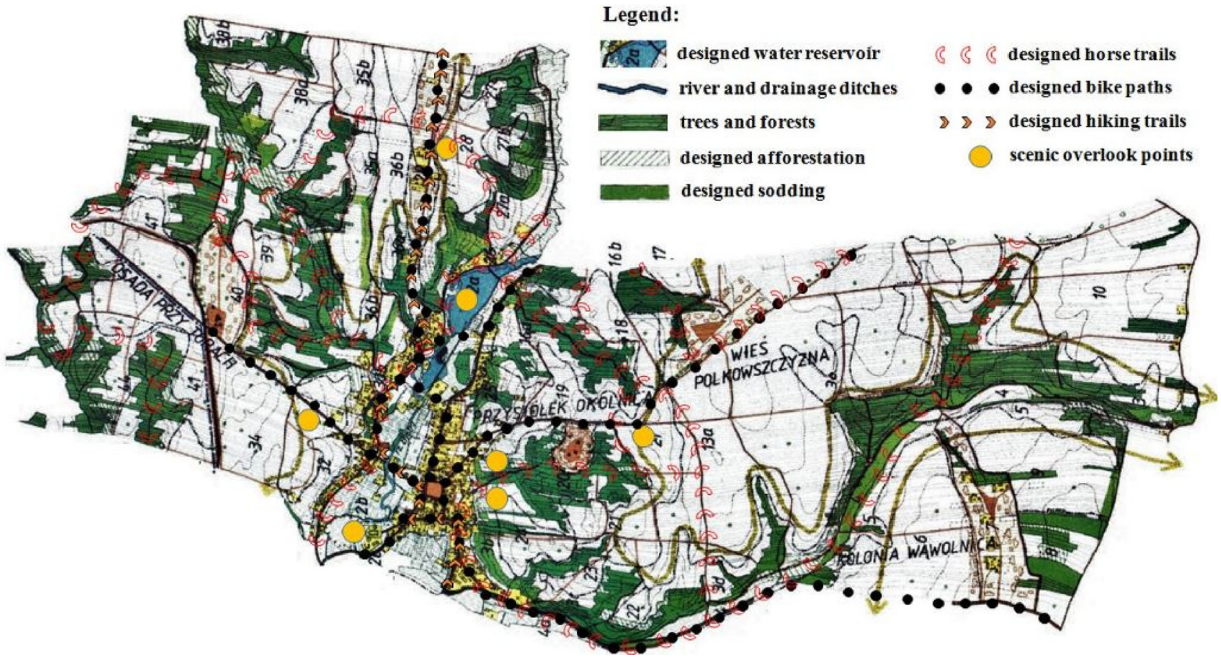

Fig. 7. Selected design solutions planned within the rural development project in Wąwolnica-Zarzeka (Source: Ministry of Agriculture and Rural Development).

Fig. 8. Locations of the two example projects Munnikenland and Bussloo in the Netherlands (Source: own elaboration).

Fig. 9. Map of Munnikenland in 1950 (top left) (Source: Bonnebladen, 1950); map of current situation (bottom left) (Source: own elaboration); impression of newly constructed lakes (top right) and new dike under construction (bottom right) (Source: photographs by J.M. van Loon-Steensma).

intensively used for dairy production, except for the area near Loevestein Castle, which was designated a nature conservation area in the 1970 s (Regionaal Archief Rivierenland, 2015).

The area used to be protected by dikes, managed and maintained by a water board. The water board was also responsible for management of the groundwater level and drainage system. In 2006, Munnikenland became a “Room for the River” site, meaning that measures were undertaken to reduce the river level during extreme discharges by giving the river more space, while also relocating and improving the dike.

The local water board initiated a process to develop a comprehensive planning vision for Munnikenland, including flood defences. A range of local stakeholders, experts and artists contributed to an integrated vision for improving flood safety while strengthening the area’s cultural, historical, natural and recreational value. The plan envisaged a shift away from agriculture towards nature and recreational values by excavating the floodplains and creating ponds and creeks (Ger de Vrieze, pers. comm.). This plan has now been implemented. The excavated material from the floodplains was used to over-dimension the

Table 3
Functions and planned activities under the Munnikenland "Room for the River" project.

Functions	Planned Activities
water retention	- creating water retention area by creating water bodies on the former agricultural land
flood protection	- creating water retention area (in order to reduce river water level during extreme discharges) by relocating the dike, excavating floodplains and creating water bodies on the former agricultural land
	- relocating the dike and adjusting the dimensions of the new dike
agriculture	- moving agricultural businesses and agricultural land use from the area
nature	- creating riverine wetlands
	- development of flood proof elevated places for cattle (used for nature management) by shelter during high water events
recreation and tourism	- creating attractive and accessible riverine nature area
	- allowing the use of the dike as an open-air theatre by over-dimension the dike
	- placing information signs, benches and picnic places
landscape	- development of a semi-natural riverine landscape
infrastructure	- development of roads to access the Loevestein Castle and parking places
	- construction of cycle paths and hiking trails

newly relocated dike. This planned over-dimensioning has created a dike suited for recreational use and also provided a place for cattle to take refuge during high-water events. Furthermore, new roads have been built to improve the accessibility of the newly created riverine nature in Munnikenland and the Loevestein Castle cultural heritage site.

This example illustrates that in the Netherlands flood risk objectives (resulting from the foreseen impact of climate change) may result in a complete shift of functions and comprehensive adjustment of a rural area (Table 3).

4.2.2. Bussloo "TOP"area

Bussloo Recreation Park (52°12′ N, 06°06′ E) is located in the Veluwe, a forest-rich sand ridge (1100 km^2) in the central Netherlands. Park Bussloo is some 300 ha, which includes a 100 ha lake that was dredged in the 1960 s for sand excavation for the nearby A1 motorway. The park, opened in 1977, is located in a predominantly agricultural area, but to its south is the "Appense Veld" nature reserve (Fig. 10). Designed to combine recreation, agriculture and nature in a sustainable way, it significantly contributes to the local economy and quality of life. Park Bussloo is located in a so-called "TOP" area; that is, a location where intensive drainage has resulted in drought stress due to lowered water tables. In 2007, the Dutch government initiated a plan to rehabilitate 70,000 ha of TOP areas. For each site, the provincial government was to establish a target for groundwater and surface water levels (Ministerie van Verkeer en Waterstaat, 1998). Regional water boards were given responsibility to achieve these targets, but this was to be done in consultation with other stakeholders. In Bussloo, the stakeholders are the Veluwe Water Board, Leisurelands (the park owner) and the De Poll Estate, which manages the nature reserve.

A compromise had to be found between the requirements of respectively the park and the nature reserve. To reduce drought stress in the nature reserve, De Poll Estate indicated its preference for maximum lake levels, though this would result in strong lake level fluctuations. Leisurelands, however, preferred a constant lake level to guarantee the safety of swimmers. As a compromise, the water board recommended a target level in winter of 5.20 m + MSl and 4.90 m + MSl in summer (Jansen, 2012). A higher water level would pose disadvantages for the recreation function, such as loss of beach surface and the need for additional shore protection measures. It would also require more frequent beach cleaning and continuous adjustment of safety lines to ensure safe bathing. Raising the lake level by 0.5 m would require a €500,000 investment and raise the cost of annual operations and maintenance by some €40,000. Furthermore, maintaining this target level would be difficult, as the main inflow and outflow takes place through groundwater. As a consequence, the lake water level regularly drops below the minimum target of 4.90 m + MSL, leading to drought stress of the vegetation in the nature reserve.

This example demonstrates the complexity of water management for combined land uses – in this case, for agriculture, nature and recreation. Invariably, compromises must be made between the different land use requirements (Table 4).

5. Discussion

Similar approaches to land consolidation and water management to improve agricultural production were developed in Poland and the Netherlands at the start of the 20th century. Both countries have used land consolidation and associated water management measures to solve problems of small and fragmented farm holdings and to improve agricultural returns. These projects have been very successful. After World War II, land tenure developments in the two countries took different directions. In Poland the focus shifted to concentration of state and cooperative lands, while farmers' needs were neglected. Poland's political and economic system determined the scope of construction of irrigation and drainage systems, river regulation projects and land consolidation works. They were performed for the benefit of the socialist economy and aimed at concentration of lands in state and cooperative hands. When the socialist regimes ended, interest increased in improving farming conditions on individual holdings. In some cases, urbanized rural populations kept a small holding they had been allocated as a fall-back option (Korthals Altes and Im, 2011). According to Pašakarnis and Maliene (2010), state intervention will be required to reverse the current land fragmentation.

While the main land consolidation challenge facing Poland is a rather traditional one, the Netherlands (like several other western European countries), has shifted the focus of its land consolidation programmes to overall rural development, including village renewal, economic diversification and environmental and landscape conservation (Van de Ven, 2004). Recently, approaches in both countries began to come together again. Stimulated in part by agricultural policy reforms in the EU context, and the introduction of the EU Water Framework Directive (2000), gradually more attention is being paid to non-agricultural land uses, including nature and ecological values and to integrated water management. Increasing attention for the impact of climate change and the rise of climate change adaptation on the international agenda, alongside the advent of EU funding programmes for this purpose, have fuelled the development of new approaches and a renewed mutual interest in collaborating and learning from previous experiences and from other countries.

History offers many examples of links between Poland and the Netherlands concerning socio-economic developments and exchanges of ideas, culture and technological innovations. From the Middle Ages onwards, trade by sea resulted in migration and exchanges of skills, ideas and practices, for instance, regarding drainage, dredging and land reclamation. The socialistic period formed a temporary interruption, but shortly before the end of the socialist period in Poland in 1989, collaboration and exchange between Poland and the Netherlands was

Fig. 10. Map of the Bussloo site in 1950 (top left) (Source: Bonnebladen, 1950); map of current situation (bottom left) (Source: own elaboration); impressions of lake and recreation area (top right and bottom right) (Source: photographs by J.M. van Loon-Steensma).

Table 4
Functions and planned activities under the Bussloo "TOP" area project.

Function	Planned Activities
water retention	- regulation of water levels in the lake
flood protection	- regulation of water levels in the lake
agriculture	- low water levels in growing season (March-September)
nature	- maximum water levels and minimum outflow in winter
	- maximum water levels and minimum outflow in summer
recreation	- constant water levels in summer
landscape	- combining various land use functions
infrastructure	already in place

started again. The Dutch government funded several training courses and master's programmes involving students from communist states studying, for example, irrigation and drainage, water management and agricultural production (Ewa Wietsma-Łącka, pers. comm.). The Netherlands and Poland subsequently took part in exchange projects in the early 1990 s, as part of the Tempus Programme of the European Commission (Ewa Wietsma-Łącka, pers. comm.). Dutch and Polish scientists collaborated, for example, on questions regarding the pristine riverine regions in eastern Poland. This all formed a base for further collaboration and learning from experiences regarding the integration of water management and land consolidation projects to create robust and climate-proof areas.

Our case studies demonstrate significantly different approaches in Poland and the Netherlands. Dutch land consolidation projects have a more multi-purpose character, whereas in Poland land consolidation projects still aim mainly to improve agricultural production (Table 5). The two adaptation measures, i.e., water retention and flood protection, to meet the rising challenges of water management related to climate change are more effective in the Netherlands. There, they better serve

Table 5
Overview of project effectiveness in the four case areas, based on Tables 1–4 (Key: + = action implemented; - = action planned, but not implemented; +/- = action implemented, but not sufficiently; N.A. = not applicable).

	Siedliska	Wąwolnica-Zarzeka	Munnikenland	Bussloo
water retention	+	+/-	+	+/-
flood protection	+/-	–	+	+/-
agriculture	+/-	+	removed	+
nature	+/-	N.A.	+	+/-
recreation and tourism	N.A.	+/-	+	+/-
landscape	+	+/-	+	+
infrastructure	+	+/-	+	+

the multiple functions of nature, recreation, landscape and infrastructure.

The main reasons why the adaptation measures in the Netherlands were more effective are discussed below.

5.1. Multidisciplinary approach

Rural development projects try to integrate functions such as agriculture, infrastructure, landscape, drainage, flood protection and recreation. The four case studies suggest that integration of nature and recreation in Poland lags behind developments in the Netherlands. Achieving such multidimensional ambitions requires the cooperation of many specialists, including surveyors, hydrologists, landscape architects and agricultural economists.

5.2. Participatory approach

In the Netherlands, public participation is more formalized than in Poland since it has a mandatory character, and it may take place in various ways, especially with regard to reallocation plans. Before the Dutch government makes a formal decision on a new allocation, the involved farmers are invited to several meetings and work sessions to collaboratively consult and adapt the proposed allocation (Louwsma et al., 2014). The Netherlands applies several tools to facilitate land consolidation processes, such as a so-called allotment barometer. This allows the farmers to take responsibility for their own environment, and therefore influences their involvement in the project. However, public participation in the Netherlands is generally informative; it is the government that is responsible for formal decisions.

In the Polish cases, lack of stakeholder participation in the rural development projects made it difficult to achieve optimum project designs. What is more, lack of stakeholder inputs led to unrealistic project designs. As yet, Poland has no services that would allow the public to access online information on the impacts of land consolidation projects and to comment on plans or propose adjustments. Introduction of a more participative approach, i.e., with the full involvement of local communities, associations and others, would improve project effectiveness. It could raise public awareness about the process and serve as an aid to identify the actions and design solutions that are most desirable or those that lead to the most acceptable compromise. This might lower the number of appeals to court.

5.3. Public awareness

Another key issue is raising public awareness on matters related to rural development. The Dutch bottom-up approach to land consolidation called “Re-allotment for Growth”, developed by DLG (Government Service for Land and Water Management) and LTO (Agricultural and Horticultural Organization), stimulates awareness among farmers on the land consolidation process, in order to establish support among land owners (Leenen, 2014). In general, Dutch farmers are aware that a good re-allotment, combined with adequate infrastructural developments, will contribute to improve the quality of their work and life (Leenen, 2014).

Polish farmers, however, are still insecure about the effects of land consolidation. In our Wąwolnica-Zarzeka case study, achievement of the intended goal (creation of a water reservoir) was hampered by lack of stakeholder support. Polish farmers are not fully aware of the positive effects of land consolidation and the wide range of possible solutions. Interviews with farmers, representatives of the state administration and local officials confirmed this lack of awareness among farmers. Furthermore, prejudices and presumptions, alongside strong attachments to land rooted in the previous period of socialism, may hamper the land consolidation process. Raising public awareness may help to overcome these hurdles.

5.4. Communication and promoting the process

In the Netherlands a lot of effort is spent in garnering support through communication and stakeholder participation. For example, the Water Board Rivierenland (Munnikenland project) kept inhabitants informed with monthly newsletters about “Room for the River” projects and by organizing meetings. This helped to overcome the initial resistance, and resulted in their cooperation. The Polish case studies clearly indicate the necessity of undertaking actions promoting land consolidation and water management, such as informative meetings with rural communities, folders, newsletters, leaflets and the like. Promotional activities increase community interest in land consolidation projects, while indirectly raising public awareness of the multipurpose approach.

5.5. Financial framework

In the Netherlands the Rural Development Act (2007) caused a decentralisation of the land consolidation process and allowed several legal instruments to be brought under one umbrella (one budget). The responsibility for the execution and financing of projects was placed with the provincial governments. In Poland, there remains a lack of institutional and financial frameworks to stimulate integrated approaches to rural development; that is, rural development initiatives draw on diverse sources of finance and different organizations and institutions are responsible for implementation of particular tasks.

It would be advisable to create legal and organizational arrangements that synchronize consolidation works and water management works together in a single investment process, so both can be carried out from one source of funding under European funds. Without systemic changes and adaptation of appropriate legal regulations, integrated rural development projects will continue to be rare in Poland, and classic land consolidation projects (aimed at improving the configuration of farms and the agricultural road network) will continue to be the norm.

5.6. Landscape values

The Netherlands has to cope with environmental trade-offs emanating from previous choices regarding agricultural intensification, scale enlargement and regional concentration (Bos et al., 2013). Polish farmlands display a variety of land uses. The Dutch experience suggests that emergence of large-scale monocultures should be avoided. In Poland, the occurrence of small and fragmented farms (which are less effective from the point of view of agricultural management) is advantageous in terms of landscape and environment. The large variety of land uses in the form of plot patchwork produces a valuable diverse landscape and prevents agricultural monocultures, whereas the presence of large-scale farms with specialized production results in a uniform landscape with impoverished biodiversity.

5.7. Climate proofing the rural area

In the Netherlands, the increasing attention for the impact of climate change and the subsequent incorporation of climate change adaptation goals in water policy (i.e., the Delta programme) forms an important incentive for new projects in the rural area, such as “Room for the River”. Because governance aspects of flood protection and water management measures are so strongly embedded in the Dutch culture, even land expropriation is feasible if safety is at stake and no alternative solutions are available. However, normally much effort is spent in garnering public support through communication and stakeholder participation. Farmers form a key stakeholder group in new projects, and it is recognized that they will only want to cooperate if they see benefits or if they are (financially) compensated.

6. Conclusions and recommendations

Since the 1970 s the focus of land consolidation has been widened to include rural development overall. Gradually, more attention has been given to non-agricultural land uses, including nature and ecological values. At the same time, nature conservation and the environment have risen in importance. Water management over time has become an increasingly important aspect of land consolidation programmes. This is due to the exacting requirements of modern intensive farming, the rising importance of nature and landscape conservation and the increasing appreciation of rural enterprise and recreation facilities. Recently, concerns about climate change have led to more adaptive and participatory approaches to water management, and to the exploration of adaptations in rural areas. Moreover, the potential of multifunctional land use has been investigated as an adaptation measure. Functions

including flood protection, water retention, agriculture and nature conservation may overlap with, for example, village renewal, business development and recreation. Because of the complexity of fashioning such combinations, compromises invariably need to be made between the different goals and stakeholders.

The Netherlands and some other western European countries have already incorporated climate change-related goals and adapted local water management practices in their land consolidation projects. Other countries, including Poland, may benefit from these experiences in blending rural development, water management and climate adaptation in land consolidation projects from the start. Poland, on the other hand, gained valuable experience in land consolidation projects in the changing and increasingly complex rural environment after the end of the socialistic period. Our case studies show that rural development in both Poland and the Netherlands is nowadays based on an multidisciplinary approach. Aspects on which Poland can learn from Dutch experiences regard the inclusion of recreation values and enhancement of participatory approaches, alongside increasing communication and public awareness.

Finally, it would be advisable to create legal and organizational conditions in Poland to synchronize consolidation works and water management measures together in a single investment process. This would enable both activities to be carried out from one source of funding. Without systemic changes and adaptation of appropriate legal regulations, integrated rural development projects will continue to be rare in Poland, and classic land consolidation projects (aimed to improve the configuration of farms and the agricultural road network) will continue to be the norm.

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